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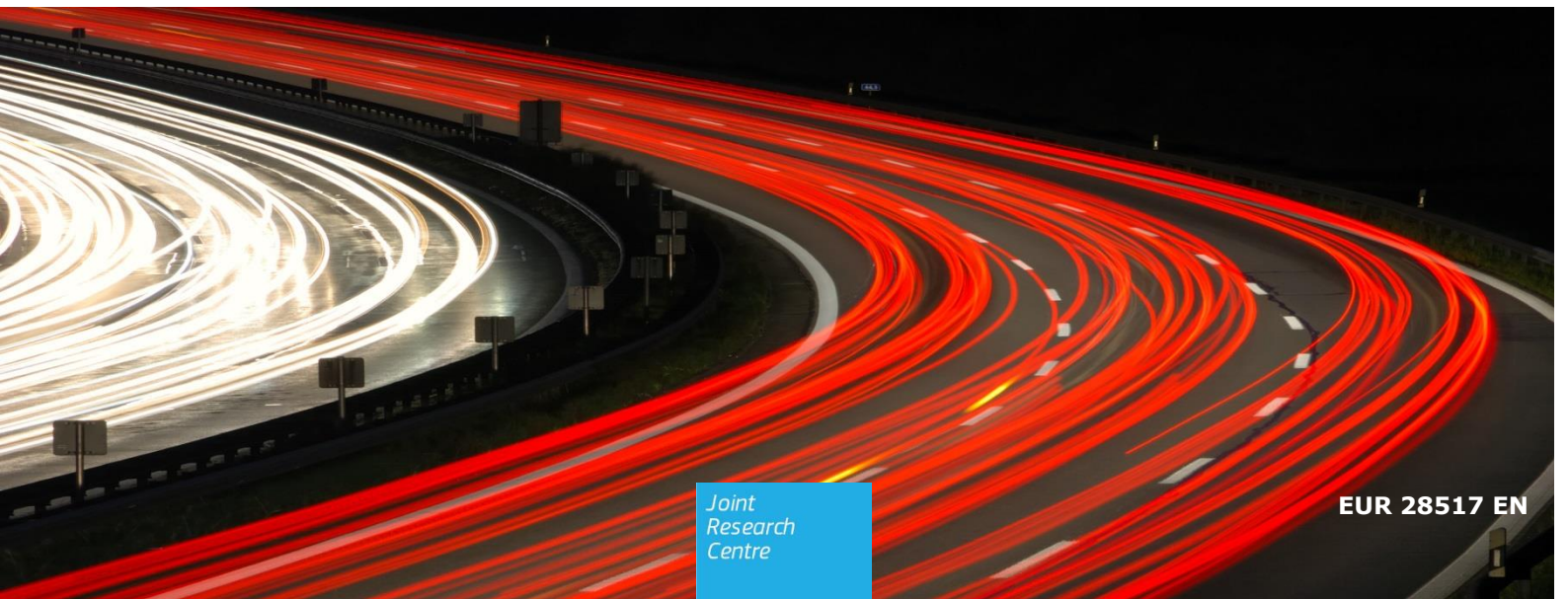

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What drives car use in Europe?
What affects user choices regarding car use in the EU? The methodology is based on the results of a recent EU-wide travel survey that maps user preferences and on the application of a Random Forest classification model that explains the interaction of the main variables that affect these choices.

Contents

Executive summary

The approach presented here sheds some light into the interaction of the variables that affect user choices as regards car use. It is clear that many of the factors are interdependent, as for example the level of urbanisation and the availability of public transport. The analysis of the importance of the factors allows the policy maker to identify better where policy measures can influence user choices. Targeted policies that address specific demographic groups or land use types in each individual country would be more successful than *one size fits all* approaches.

Policy context

The White Paper on Transport (Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, COM(2011) 144 final) set ten objectives for a competitive and resource efficient transport system in Europe and defined a roadmap including 40 concrete initiatives, amongst them fourteen which are directly linked to passenger transport.

A large majority of European citizens live in an urban environment, with over 60 % living in urban areas of over 10 000 inhabitants. They live their daily lives in the same space, and for their mobility share the same infrastructure. Urban mobility accounts for 40 % of all CO2 emissions of road transport and up to 70 % of other pollutants from transport.

European cities increasingly face problems caused by transport and traffic. The question of how to enhance mobility while at the same time reducing congestion, accidents and pollution is a common challenge to all major cities in Europe. Congestion in the EU is often located in and around urban areas and costs nearly EUR 100 billion, or 1 % of the EU's GDP, annually.

Efficient and effective urban transport can significantly contribute to achieving objectives in a wide range of policy domains for which the EU has an established competence. The success of policies and policy objectives that have been agreed at EU level, for example on the efficiency of the EU transport system, socio-economic objectives, energy dependency, or climate change, partly depends on actions taken by national, regional and local authorities. Mobility in urban areas is also an important facilitator for growth and employment and for sustainable development in the EU areas.

Key conclusions

It is premature to talk about a paradigm shift in car use. The fluctuations in car activity and – in some countries- the apparent saturation of car ownership are to a large extent the results of a combination of economic and demographic trends that resulted in younger generations being –at least for the moment- less dependent on cars. According to the importance of the factors analysed, a significant change in the level of car use would be the result of a change in car ownership levels or the share of the population holding a driving licence. There is still no evidence of either of the two indicators changing their trend in the EU.

Main findings

The results of the analysis presented here suggest that it is probably too early to assume that car travel demand is close to a peak throughout Europe. It would be more accurate to claim that a plateau has been reached in a few EU Member States with a developed economy, high car ownership rates and slowly changing demographic profiles. Evidence shows that in some of these countries car use has peaked. However, significant growth in car use should be expected in Eastern Europe. The trends concerning the use of

passenger cars are certainly not uniform across the EU since each Member State has its own socio-economic conditions and follows a different path as regards car dependency.

In addition, some of the indications of changes in trends can be circumstantial or temporary, as for example the impacts that the economic crisis may have on car ownership and use. Others are long term and perhaps not clearly visible yet. The changing structure of the economy, the longer periods of education for the young, the more fragmented and deregulated labour market and the changing cultural values (i.e. the high value of digital connectivity) may be gradually changing the role of the car in the society in the long term, but there is still not sufficient evidence to suggest that they already are having an impact throughout Europe.

Part of the impact of the factors analysed here may simply be the result of postponing decisions related to car use. However, even postponement alters the total level of demand, for if one age group now makes fewer trips than it did before, it lowers the overall level of demand. Evidence also shows that the young groups who are now postponing driving a car do not reach the levels of car use in their 30s and 40s that the generation before had. Some who postpone using the car will forever abandon car driving.

Related and future JRC work

The Economics of Climate Change, Energy and Transport (JRC-ECCET) Unit of the Directorate Energy, Transport and Climate of the JRC supports the European Commission (EC) services responsible for policy making in energy and transport through the development and application of simulation models, quantitative evaluation methodologies and technology monitoring mechanisms. In this context, JRC-ECCET provides other EC services with techno-economic analyses and impact assessments of policy measures and technological developments for energy and transport. Further information on the work of the JRC-ECCET Unit can be found on the following JRC website:

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Quick guide

The approach distinguishes between the main factors that may affect car use, namely economic, infrastructure, geographic and demographic, and analyses how their trends can influence user behaviour. This analysis is complemented by the use of the results of an EU-wide survey on transport and mobility in order to estimate the importance of each factor for the choice of transport mode.

1 Introduction

In 2011 Adam Millard-Ball and Lee Shipper presented the evidence that something quite dramatic had been happening in people's mobility in eight developed nations. Car travel had started to decline. They noted car travel had been declining. Car travel has been persistently falling or stalled in much of Europe and North America for the past 10 years. In the USA the amount of car travel is back to what it was in the early 1990s. In many Western European countries such as Great Britain, France and Germany the trends are similar. What had also been noticed, was that it was young adults that displayed the greatest tendencies to shift away from the car including a marked reduction in the number of new driving licenses issued, especially so for young men.

There is a growing literature on the theme of levelling off or declining car use. The research is nearly always based on countries that display such trends. However, it is quite unclear how widespread is this phenomenon. In many Western countries there is no discernible "peak car" effect. This paper aims to partly fill in that gap through an analysis the level of car use in each European Union country. Furthermore, by analysing the data of a unique household travel survey undertaken in every European Union country, it attempts to find major factors that are associated with changing levels of car use.

The current trends portray a quite disparate picture amongst the different countries of the European Union regarding car use, with some of them, mainly in the East showing still quite a robust growth. In this paper, the driving factors influencing car use were analysed using a Random Forest classification algorithm. The algorithm was applied on the responses from 26,500 questionnaires across the EU and estimates the contribution of various socio-economic, demographic and geographic variables to user choices. This approach allows the interactions between the variables to be captured and provides a framework for the decomposition of the trend in car use into a combination of trends in the underlying variables. As a result, the analysis of the underlying trends provides useful input to the discussion on whether car use is undergoing a paradigm shift or whether the observed trends are simply circumstantial.

2 Evidence of peak car use

That car-driving rates have stopped growing and in many cases are declining in most economically developed nations is unquestionable. The debate is as to (i) how permanent is that, (ii) how far is it related to purely economic factors, and (iii) what may be other underlying causes. Furthermore, it is accepted that the greatest change in driving rates is amongst the young, especially young men, who also are increasingly not learning how to drive.

2.1 The data

Most of the research on peak car has focused on single country data analysis. Of those, the United Kingdom has seen the most research undertaken and this research paper reflects that. The peak car phenomenon in the United Kingdom had been well documented and continues to be updated by Gordon Stokes (2015) who has, and continues to, analyse the annual National Travel Survey (NTS) of Great Britain. Some other studies, such as those by Scott Le Vine and Peter Jones (2012) have shown that although the 'peak car' phenomenon has indeed occurred in the United Kingdom, it is not universal for all groups in society. They highlight that car driving among women has been indeed increasing consistently outside London.

The groups that have shown the greatest decline in car driving are the young, the urban dwellers and those of higher incomes (Department of Transport 2015). A 30-year cohort analysis by Transport for London has shown a decline in car use both as drivers and passengers for younger males and females (Transport for London 2014). Studies on the take up of car driving licenses by young people also show significant declines in a number of countries. For instance a comparative study by Michael Sivak and Brandon Schoettle (2011) shows that driving license holding for young adults has declined in Great Britain, Norway and Sweden. Yet the opposite can be seen for Finland and Spain.

2.2 Young people

Gordon Stokes' (2013) analysis highlights the importance that changes in the mobility behaviour of young people are having in the overall level of car use. Similar results have been seen in a number of countries. An example of this is in Holland, where Jan Van der Waard shows that car mobility for young adults has decreased sharply since 1995 and demonstrates that the changing mobility of the young plays a "substantial contribution" to the 'peak car' phenomenon. Tobias Kuhnimhof, Dirk Zumkeller, and Bastian Chlond (2013) and (2014) reporting on a six-country study covering travel trends since the 1990s found that the decrease in young adults' orientation towards the car as a means of getting around did indeed contribute significantly to the recent stagnation in car travel . The changes over time for car use have been analysed by Gordon Stokes (2015), showing how the lower levels of driving for younger people feed in through time to lower the overall figures of car use.

The take-up of driving licenses amongst the young has also shown to be declining in a study by Alexa Delbosc and Graham Currie (2014). In a further study undertaken by Tobias Kuhnimhof, Ralph Buehler and Joyce Dargay (2011) comparing travel patterns of young people in the United Kingdom and Germany, conclude: "this substantiates findings that the historic trend towards increasing motorisation may have come to an end for young Germans and Britons".

Although many analysts have shown the changing mobility patterns and travel behaviour of the young are a major, if not determining factor in the 'peak car' phenomenon, there have been only a few studies directed at the changing nature of their mobility. The only studies that have been published are those that have compiled evidence from a variety of sources to try to suggest some hypotheses on the drivers that have led to young persons' reduced reliance on car travel. One such example, is that of Benjamin Davis and Tony Dutzik (2012) of the Frontier Group that assembled a series of results from both quantitative and attitudinal travel data in the USA. Scott Le Vine (2014) has also assembled such data for the United Kingdom.

The major question for a number of researchers and policy makers is what is going to happen to the young people, as they grow older. According to the United Kingdom's Department of Transport (2015), it is amongst young people where perhaps the greatest uncertainty lies. "If they continue to delay major life events, staying in cities longer, and only driving more when they get older and move out to rural areas – they may not increase their car use until later in life. Furthermore, there is the possibility that this cohort's attitude to the car has fundamentally changed and habits become ingrained so that their car use remains at lower levels". However, the Department of Transport (2015) rebuts this possibility, claiming "there is little evidence at present to suggest that this is the case". A recent study in Holland based on an analysis of the Dutch National Travel Survey from 1995 to 2009 and a specially commissioned attitudes survey in 2013 (Jorritsma and Berveling 2014) found that "it is highly likely that young people are delaying buying a car because car ownership does not fit in with their current lifestyle. When they get married and/or have children, they will decide to buy a car after all." They state that it is "too early to conclude that young adults are turning their backs on the car. Generation Y does not want to be car-less, but car-later". However, existing evidence in the United Kingdom (Stokes 2015) and London (Transport for London 2014) shows that the lower level of driving continues with age for the younger cohorts and has done so for the past two decades. The most in depth study on this issue, by the Social Research Association (2015) having interviewed 1,940 people under the age of 30 in Great Britain in 2015, states, that "the vast majority of young people cite cost factors as the main reason why they are driving less. But this is not the whole story since even those who did own cars often prefer to travel by public transport, walking or cycling (41% of all short trips and 27% of long trips). There are also a growing number of young people who say they don't ever want a car and this increases with age. Thus 15% of non-car owners

aged 17-29 don't want a car in the future compared to twice as many (32%) of non-car owners aged 30-42".

Furthermore, there is the question as to whether the very young now (under sixteen), when they will become of driving age, will they also have lower driving rates as the current young generation? Some recent studies in the United Kingdom (Chen, Le Vine and Polak 2014) and the United States (Blumenberg et al. 2012) suggest that current early teens may be more inclined to become car drivers that current young adults, with economic factors playing a key role in the decision making process. However, we do not have the aspirational data of the current young people when they were under the age of sixteen, to know how such aspirations pan with time.

2.3 Causes for a decline in car use

There have been several researchers investigating trends in car use at an aggregate and to some lesser extent at a disaggregate level. Nonetheless, the reasons for the decline in car use are still not well understood. Most commentators claim that this decline is likely to be due to a combination of factors. There are some analysts however, such as (Bastian and Börjesson 2014) in Sweden that have claimed that a combination of fuel price and GDP are enough to explain the peak car effect of that country.

Although car use may have peaked car availability, especially outside urban areas is still increasing, as is shown by Grimal (2015) in France. Indeed a car use by car availability statistic would show a more dramatic downward effect than the widely used, car use per capita.

However, which of these factors are the most relevant, is still to be explored. The main categories of factors have been identified by a number of researchers and studies including (Chen, Le Vine and Polak 2014), (Department of Transport 2015), (Goodwin 2012), (Goodwin and Van Dender 2013), (Headicar 2013), (Jorritsma and Berveling 2014), (Lyons and Goodwin 2014) and (Metz 2015) can be summarised as follows:

a. Economic factors:

- General economic conditions including recent adverse economic conditions in the United States and Europe,
- Falling employment rates, especially for the young,
- Fuel prices, cost of learning to drive, acquire and run cars, congestion charging, insurance costs, parking costs,
- Changes in regulation, taxing and funding of company cars, especially in the United Kingdom.

b. Changes to the relative quality and reliability of different modes of travel, including public transport, cycling, walking and private car travel:

- Improvements in public transport, due to improved infrastructure and better operations and improved passenger information,
- Traffic congestion,
- Provision of cycle lanes and improved facilities for pedestrians,
- Traffic calming in residential areas,
- Reallocation of road capacity from car to wider pavements, priority lanes, etc.,
- More restrictive parking conditions and policies,
- Increased availability and lower prices of alternative long distance mode (rail, air) that may lead to mode substitution.

c. Developments in land use planning:

- Redevelopment of brown-field sites and inner city areas with high densities,

- Retail and service development favouring urban localities rather than out-of-town sites,
- Inner city development of a type which becomes preferred by higher income groups and opinion formers, changing fashions away from suburbs,
- Development of urban rail systems with consequential impacts on property values and attractiveness of locations well served by public transport.
- New cultural/social/technical patterns and preferences seen as influences on behaviour
- Cultural and psychological shifts including a cooling or disappearance of the 'love affair with the car' including motivations of environmental impacts and personal health,
- Various different forms communications technology leading to increased electronic commerce and homeworking (teleworking),
- Cultural changes such that the driving license as a key rite of passage into adulthood no longer has the universality it had seemed to be acquiring, especially among young men.

d. Demographic changes:

- Changing demographic structures and lifestyles, including a prolonging of particular life-cycle stages,
- Increasing rates of participation in education and corresponding decreasing rates of employment,
- Growth of immigrant numbers who bring different cultural attitudes and habits of travel,
- Ageing population.

2.4 Hypotheses on peak car

Phil Goodwin (2011) systematically analysed the research and debate on the 'peak car' phenomenon. He breaks down the ideas that belie the interpretations of the lack of growth and/or decline in car driving and identifies the main themes and issues associated with 'peak car'. He not only systematises the nature of the debate but also offers three possible hypotheses that aim to explain the 'peak car' phenomenon. The three hypotheses are:

- The 'Interrupted Growth' hypothesis states that the main reasons for recently observed changes in trends are the effects of three key drivers, namely income measured as GDP per head, population, and the cost of motoring. Current assumptions about the future changes in income, population, and fuel price combine to suggest that car traffic will continue to grow, for several decades into the future. One of the key proponents of this theory is the United Kingdom Department of Transport (2013) and (2015), which lays faith in existing transport forecasts, even if they at present are not matching reality.
- The 'Saturation' hypothesis is based on the assumption that car traffic will reach a maximum point. It proposes that car use per head has broadly already reached, or is close to, the maximum level it ever will, because more car use does not give greater cost or time benefits. Traffic congestion and the alternatives offered by public transport, walking and cycling determine that 'peak'. This theory is also supported by the work on travel budgets by David Metz (2010).
- The 'Peak Car' hypothesis considers that car use per head is passing through a peak and the current downturn may be an early sign of a long term decline in car use, due to a complex combination of drivers in which economic influences are modified by policy, attitudinal, social, technological and cultural changes.

2.5 Further issues to explore

What nearly all the studies on the peak car effect call for, is the need for further research, especially attitudinal and motivational, that can add explanative reasoning to the observed changes in travel behaviour, especially for young adults. For instance, Jan Van der Waard (2013), states, "although much quoted in publications on reduced car mobility, a significant change in the attitude of young adults could not be determined through existing research". And, Alexa Delbosc and Graham Currie (2013) state, "the whole search for causal influences is confounded by a lack of studies" and conclude "further research will help us understand the drivers of these trends".

Understanding the drivers of travel demand aids us in understanding the levels of car use but also importantly, helps us in forecasting travel demand in the future. From the literature surveyed above, it seems that younger people are eschewing to a significant extent car driving. Already this has shown to have significantly depressed overall driving rates in economically developed countries to levels that existed in the 1990s. The trends so far, are still downward.

Two main unanswered (unanswerable?) questions remain.

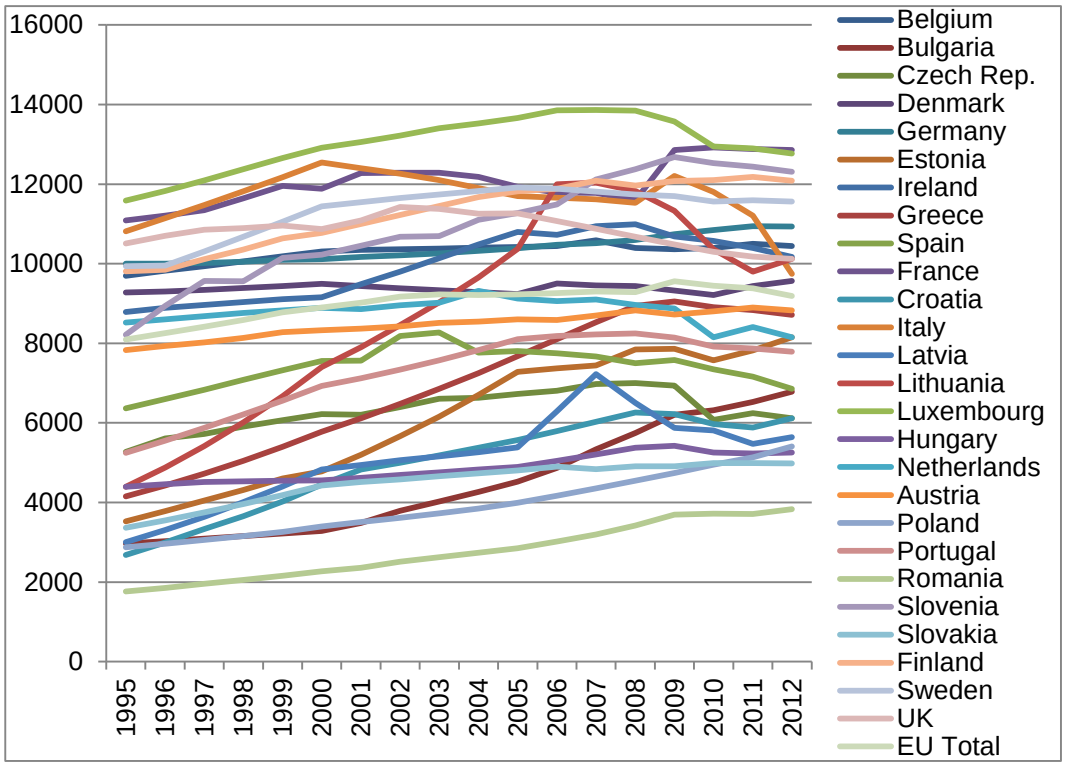
Will young people change their travel behaviour later on life to match those of a generation ago? The evidence so far is that the lower levels of driving are carried through in life by the younger cohorts. Will this continue? The United Kingdom's Department of Transport (2015), view is that it is merely delaying the inevitable, "as their incomes and employment prospects improve and costs reduce, we would expect on the basis of the existing evidence that more of them will learn to drive and use a car".

And, will the newer generation of youngsters display the same attitude to driving as the current generation? The Department of Transport's (2015) view citing findings from (Chen, Le Vine and Polak 2014) is that "the young of pre-driving age are travelling more in the car than previous cohorts did suggesting that they may be more inclined to use the car in the future". Yet a careful analysis of that study of pre-driving children and teens shows that between 2000/02 and 2008/10 they travelled by car the same amount and a slight fall in the period 2005/7 to 2008/10. Furthermore, there is little to suggest that the car passengers of the past will necessarily become the car drivers of the future.

3 Car use rates in Europe

The trends in car driving in Europe differ between countries as can be seen from the graph below.

Figure 1. Car use in EU Member States (kilometres per annum per capita)



source: Eurostat

Car passenger activity for the EU as a whole grew until 2009 and then started decreasing. However, the overall figures conceal the fact that there are important differences between driving rates in Europe. From the disaggregate country data we can discern clusters of countries that have similar economic, political and cultural histories and portray similar trends on driving rates over the past twenty-five years. The four clusters are:

- Countries facing the economic crisis (PIIGS): Portugal, Ireland, Italy, Greece, Spain,
- Western countries that peaked: Sweden, United Kingdom, Netherlands, Luxembourg
- Western countries with stable growth: France, Austria, Germany, Denmark, Finland, Belgium
- East European countries with sustained growth: Bulgaria, Poland, Romania, Czech Republic, Slovakia, Slovenia, Croatia, Hungary, Estonia, Latvia, Lithuania

From the above clusters we can make out the following:

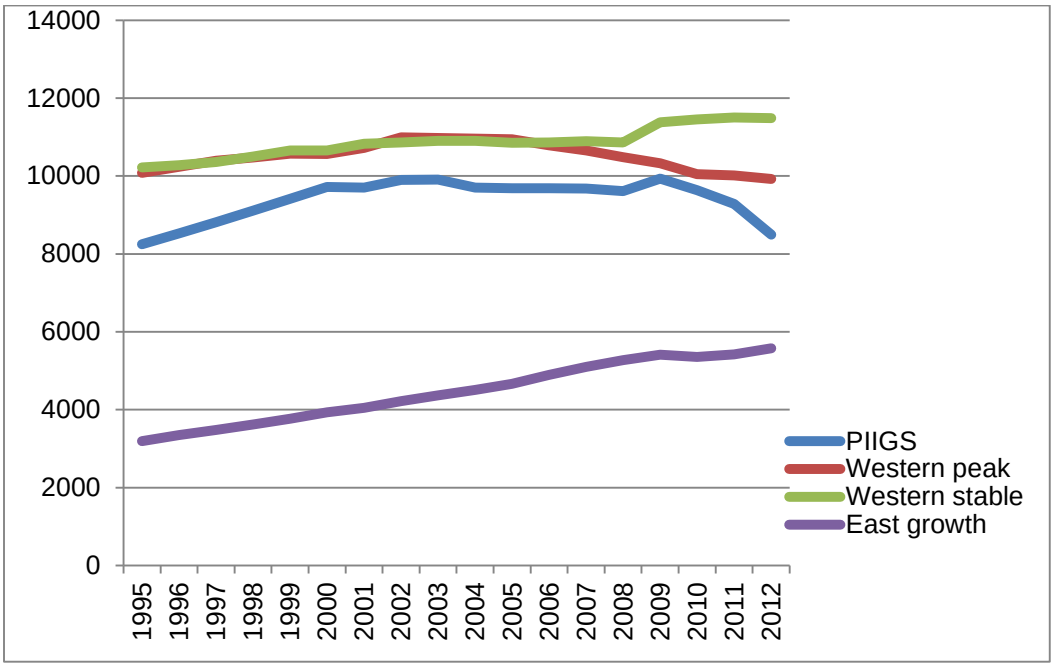
- The countries that faced the brunt of the recent economic crisis had seen that car use rates grew up to the turn of the century, and then plateaued. However since 2008/9 they have seen driving rates plummet to the levels of the mid 1990s. This

fall is in tandem with the outbreak of the economic crisis.

- Western European countries can be divided to those that have witnessed a peak and fall in car use rates and those that haven't. The United Kingdom, the Netherlands and Sweden are the countries that have peaked. They peaked in 2002, 2004 and 2005 respectively. Italy could be added to this group. Italian driving rates peaked in 2000.
- The rest of the western European countries have seen a slow but steady growth in car use rates with no discernable peak.
- Eastern European countries have seen car use rates grow but from a low base. Yet, even within this group, Hungary, Croatia, the Czech Republic, Slovenia, Lithuania and Latvia also witnessed to some extent a peak in car use rates sometime between 2007 and 2009.

The country-level disaggregate data of car use rates suggest that the richer western countries show either a plateau or peak car effect from the turn of the century. The countries of the Baltics, Balkans and Central Europe have seen a largely uninterrupted growth in car use from a low base. Yet the latest economic recession seems to have affected the car use rates in some of these countries too.

Figure 2. Car kilometres per annum per capita – Clustered EU Countries



source: Eurostat

3. Exploring the factors driving car travel demand in Europe

Given that the demand for passenger transport depends on several factors, understanding the trends in car travel demand requires an insight into its underlying drivers. In a similar fashion, assessing whether the EU has reached or is reaching a peak as regards car use entails an assessment of the trends in those factors. Moreover, the degree to which each factor influences car travel demand needs to be estimated, in order for often contradicting trends to be accounted for. The approach proposed here combines

an EU-wide travel survey which provides information on user choices with a Random Forest classification model that allows the weight of each factor to be quantified.

3.1. The EU travel survey

The EU travel survey was conducted in June 2014 and was based on the CAWI (Computer Aided Web Interview) methodology (Fiorello and Zani 2015). The overall objective of the survey was to collect information that could potentially help monitor the progress towards the goals of EU transport policy, as expressed in the 2011 White Paper (European Commission 2011). The survey focused on the use of transport modes for both daily and long distance mobility as well as on some other policy relevant issues (e.g. the attitude towards internalisation of road external costs by means of road charging). Such information cannot be collected through conventional statistics at EU level and a user survey can be an effective alternative solution.

The survey was carried out in all 28 EU member states. In each country a sample of 1000 individuals (500 in Cyprus, Luxembourg and Malta) segmented according to socio-economic characteristics was asked to fill in the same questionnaire (translated in the local language) divided into four sections:

- General information on the respondent (e.g. age, gender, living area) as well as details on availability of cars and public transport service;
- Everyday mobility in terms of mode used, frequency of trips, duration, distance, inter-modality, also collecting judgments on main problems experienced;
- Long distance trips (between 300 km and 1000 km and over 1000 km) by purpose and by mode made in the last 12 months;
- Attitude towards innovative transport services and transport policy issues (road charging, internalization of external costs, etc.).

Table 1. Summary of main survey characteristics

Country	Number of respondents	Share of female respondents	Residents in cities over 250 thousand	Respondents holding a car driving license	Respondents driving a car for their most frequent trip
Austria	1008	50%	32%	92%	58%
Belgium	1000	49%	22%	81%	58%
Bulgaria	1000	50%	52%	77%	46%
Croatia	1003	50%	29%	82%	61%
Cyprus	500	52%		95%	90%
Czech Republic	1000	53%	23%	71%	42%
Denmark	1010	51%	31%	82%	48%
Estonia	1005	51%	27%	79%	55%
Finland	1005	52%	39%	81%	49%
France	1000	50%	23%	89%	69%
Germany	1000	50%	31%	88%	58%
Great Britain	1000	50%	35%	78%	52%
Greece	1012	50%	53%	84%	51%
Hungary	1020	51%	36%	66%	33%
Ireland	1000	51%	32%	84%	62%
Italy	1000	50%	29%	92%	64%
Latvia	1000	53%	37%	74%	50%
Lithuania	1000	51%	41%	85%	65%
Luxembourg	505	50%		96%	81%
Malta	500	53%		81%	67%
Netherlands	1000	50%	27%	84%	54%
Poland	1000	49%	36%	72%	48%
Portugal	1014	50%	38%	90%	68%
Romania	1019	51%	42%	61%	33%
Slovakia	1000	51%	14%	73%	45%
Slovenia	1000	49%	16%	92%	73%
Spain	1000	49%	39%	87%	55%
Sweden	1004	50%	35%	79%	47%
Total	26605	51%	31%	82%	55%

source: EU Travel Survey (Fiorello et al, 2015 & 2016)

3.2. Random forest classification

Random Forest is a methodology that combines a large number of decision trees for classification or regression purposes (Breiman 2001). It is an ensemble learning method frequently used in machine learning which allows the evaluation of different combinations of independent variables that partially explain variance in the dependent variable. The Random Forest algorithm makes predictions by combining the predictions of the individual trees and in principle reduces the regression and classification compared to most alternative approaches. The most important advantage of Random Forests is that it allows capturing the interaction between the independent variables through its deep tree structure. The algorithm permits the estimation of the importance of each variable by calculating the change in prediction error when a specific variable is permuted while all others remain unchanged. Compared with the more conventional regression and

classification approaches, Random Forests has the main advantage of not assuming linear features or linear interactions. In addition, Random Forests handles binary and categorical variables explicitly. As a result, Random Forests is an algorithm that allows efficient modelling on large data sets and achieves high levels of accuracy.

The first step of the application in this case was to build a Random Forest model which predicts whether a respondent uses (or not) a car as the mode for the most frequent trip on a weekly basis. The objective of the approach is to estimate the probability of each respondent belonging to the class of respondents using a car. This is a typical binary classification problem, for which the dependent variable is the response to the specific question and the independent variables are the responses to other questions in the survey. The model achieving the highest precision consisted of 21 dependent variables (Table 2).

The second step of the approach allows an insight into the variables that influence most the variance of the responses. The Random Forest algorithm compares the various random decision trees that include or exclude each of the independent variables and estimates the importance of each variable on the basis of the decrease in accuracy that its exclusion from the decision tree provokes. Table 2 shows the variables used ranked in terms of their mean decrease in accuracy. The results suggest that holding a driver's license and having access to a car are main factors. Gender and age play an important role, while country specific characteristics may explain the differences further. It is worth noting that the order and importance of the variable is different for users who do use a car than those who do not. For example, country and gender are of higher importance as factors for those who do not use a car, while access to a vehicle in the household is of much lower importance. Interestingly enough, environmental concerns have a relatively low importance for participants who responded no, but still obviously higher than those who responded yes.

Table 2. Ranking of variable importance on choice to use car for the most frequent trip, all respondents

	Mean decrease in accuracy	**Choice: use car**	**Choice: do not use car**
Driving license holder	109.18	102.64	96.80
Number of vehicles in household	57.56	55.66	15.58
Gender	40.92	27.82	37.60
Country	29.88	14.50	40.43
Age	28.32	22.96	16.50
Employment status (employed/ unemployed)	14.44	5.42	17.69
Frequency of frequent trip	12.90	4.61	16.55
Household size (n. of people)	11.58	5.26	13.78
Living area (metropolitan, large city, small city)	10.80	10.29	2.63
Infrequent public transport is a problem	9.21	9.44	8.77
Parking is a problem	8.85	8.82	8.82
No bicycle lanes	8.69	8.72	8.61
Congestion is a problem	8.25	8.21	8.26
Distance of frequent trip	8.12	8.87	-0.17
Lack of coverage public transport	7.62	7.65	7.49
Frequent destination (same or other urban area)	4.53	4.89	0.24
Income level (high, medium, low)	4.07	3.15	2.07
Level of education	3.80	0.39	6.01
Public transport quality	3.63	4.09	0.20
Location (centre, suburbs)	0.77	1.27	-0.83
Environmental concern	0.73	-0.64	2.32

Holding a driver's license is a necessary condition to drive a car. The importance of holding a driver's license may be therefore distorting the importance of the other factors. It is therefore interesting to apply the model only on respondents who do hold a driver's license. The results of the test with the remaining 20 variables (Table 3) have a few minor differences in terms of the ranking of variable importance, mainly explained by the correlation of holding a driver's license with age.

Table 3. Ranking of variable importance on choice to use car for the most frequent trip, holders of driving license

	Mean decrease in accuracy	Choice: use car	Choice: do not use car
Number of vehicles in household	91.81	91.07	25.67
Gender	48.96	32.11	49.72
Age	36.41	26.60	31.09
Country	33.36	20.33	42.47
Employment status (employed/ unemployed)	22.77	9.70	25.25
Frequency of frequent trip	17.63	3.63	25.70
Household size (n. of people)	12.90	5.36	15.91
Distance of frequent trip	12.50	14.00	-0.38
Living area (metropolitan, large city, small city)	9.94	10.74	0.66
Infrequent public transport is a problem	9.64	10.04	9.01
No bicycle lanes	8.67	8.76	8.48
Parking is a problem	8.23	8.15	8.26
Lack of coverage public transport	7.97	8.12	7.69
Congestion is a problem	7.31	7.36	7.16
Public transport quality	5.29	5.93	0.06
Frequent destination (same or other urban area)	4.36	4.18	0.90
Income level (high, medium, low)	3.84	3.73	1.06
Level of education	3.45	1.26	4.25
Location (centre, suburbs)	3.23	3.41	0.41
Environmental concern	2.71	1.62	2.67

Assuming that the sample of the survey is representative of the whole population, the ranking of variable importance already accounts for the interactions between the variables and the underlying factors that affect car use. For example, the importance of the variable "employment status" is adjusted to the differences caused by varying shares of work-related trips across geographic or demographic groups.

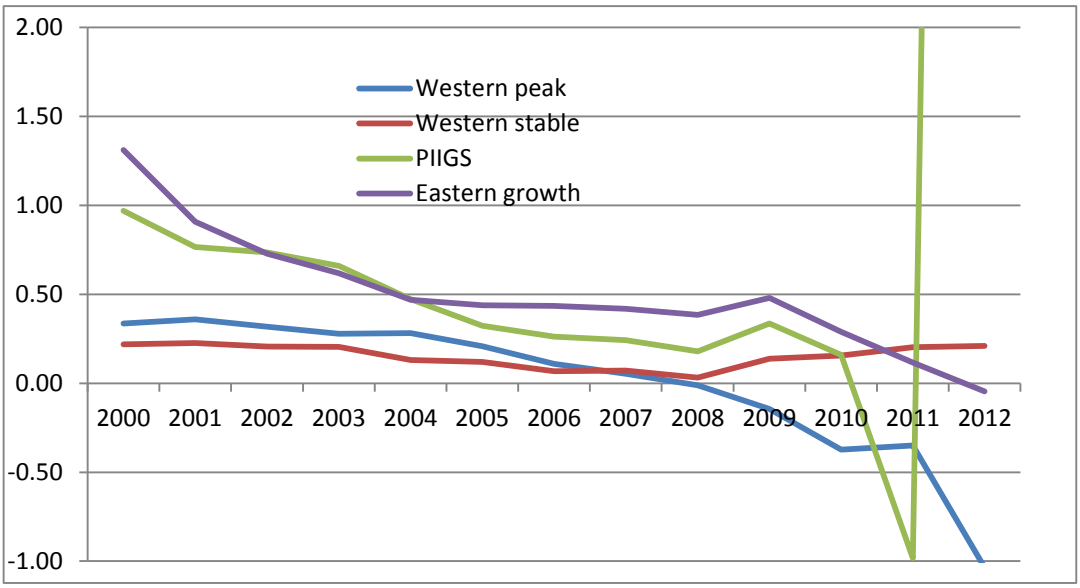
Interpreting the results is quite straight-forward in terms of the importance of the factors and –if combined with the descriptive statistics of the data set- also in terms of the direction of the impacts. It is quite safe to assert that already owning a car or living in an area not served by public transport are main reasons that promote car use. On the contrary, living in metropolitan areas, or repeating the same trip (to work, school, etc) several times a week favours avoiding the car. Male respondents use the car more than female respondents (even after employment and income status are accounted for). Car use rises with age until retirement (independently of income), but also rises with income (independently of age).

Identifying the order and magnitude of the impacts of each variable allows to transpose the discussion from the trends in car use to the trends in its underlying factors. This allows a decrease in the level of complexity of the overall question and its transformation into an analysis of a number of subsidiary, though still complicated, questions.

4. The outlook for the future

Analysing the trends in the factors affecting car travel demand can help in forming a picture as regards the possible future direction of car-based driver and passenger activity. The approach presented above identified the share of driving license holders as the factor that affects car use the most. In most of Western Europe the share of the population holding a driver's license has stabilised across generations. The generation born in the late 1950's was the first to widely adopt the car use culture and its rate of driving license holders is not significantly lower than that of the generation born in e.g. the 1970's. We shouldn't therefore expect an increase of car travel demand in the form of more users becoming drivers. On the contrary, the question is whether fewer people will be interested in having a driver's license and consequently entering the car travel demand pool. In fact, younger generations – especially people (men even more so) in their 20's living in urban areas- tend to have lower rates of driving license possession that previous generations at the same age. This is often seen as an evidence of the decreasing importance that driving a car has for these younger generations. It should be, however, noted that the rate tends to increase again when the younger generations become older. The number of driving licenses is correlated with GDP, something that suggests that a recovery from the economic crisis may provoke a rebound in the demand from younger generations. On the other hand, Eastern European countries experienced the automobile boom 10 to 20 years later than the rest of the EU. There is still room for an increase in the share of drivers due to demographic drivers which, coupled with the improvement in income levels will probably lead to a marked increase in the number of potential drivers in these countries.

Figure 3. GDP elasticity of car use, 5-year moving average



In a similar fashion, car ownership levels seem to have slowed down their speed of growth in most countries and have possibly peaked in the 'Western peak' group. Apart from some Eastern European countries where motorization rates are still catching up, most countries in the EU are close to the saturation level of car ownership of 600-700 cars per 1000 inhabitants. The saturation level corresponds to the level of average income for which an additional increase does not provoke an increase in car ownership according to Dargay (2001). Figure 3 shows the GDP elasticity of car use and clearly distinguishes the four clusters of EU countries. Western EU Member States have maintained very low elasticities for the last 15 years, with the 'Western peak' group even

shifting to a negative elasticity after 2009 (activity falls even if GDP increases). The 'PIIGS' group was gradually decreasing its elasticity to the levels of the rest of the Western part of the EU, until the economic crisis affected both car ownership levels and the average distance the cars were used for. The 'Eastern growth' group consistently shows a higher elasticity than the other three groups, with the exception of the period after 2010, when elasticity fell close to zero. The use of the car, though, may rebound when there is a recovery in economic conditions in the 'PIIGS' and 'Eastern growth' clusters. However, assuming current trends continue, it will remain stable in the 'Western stable' group and marginally fall for the 'Western peak' group. These trends suggest that car ownership levels at EU level are expected to grow moderately in the future.

Demographic trends will probably have a mixed impact on total car use. The society in general is ageing and it can be assumed that older generations will be using the car less during their retirement than they did when they were of working age, but more than the current generation of retirees. On the other hand, younger generations are expected to use a car less than comparable generations did before but, since their share in total population is falling, it is questionable whether the impact on total demand will be visible. The overall balance will largely depend on the difference between the additional car travel demand from the forthcoming more mobile older generations and the decreased demand from the future, less car-dependent, younger generations.

The local conditions also play a significant role. A part of them are explicitly covered in the survey through variables such as the size of the city and type of living area, the availability of alternative transport modes or parking space, the importance of road congestion and, to a certain extent, environmental concerns. While all these variables do play a role in actual car travel demand, it is worth exploring whether their trend in the future can lead to a noticeable change in demand levels. In fact, the variables that tend to have a direct correlation with car demand seem to be moving in the same direction. Higher availability of public transport and other alternative transport modes, increasing congestion levels have certainly helped limit demand and will probably do so in the future (assuming that these trends will hold). The type of living area and, by extension, the degree of urbanisation give however mixed signals. In principle, higher urbanisation levels lead to a higher availability of public transport and in general are associated with lower per capita car activity. From a certain point on though, urbanisation may take the form of urban sprawl, increasing average trip distances and increasing the share of car travel. There seem to be a link between high levels of urbanisation and a peak in car demand for countries such as the Netherlands, United Kingdom and Belgium (Table 4). But most of the other EU countries may face the risk of more urban sprawl as a consequence of higher urbanisation. Or, as in the case of Belgium, de-urbanisation can undo part of the gains in terms of limiting car travel demand.

Table 4. Degree of urbanisation and trend per EU member state

Group/country	% of population living in urban area (2013)	Urbanisation degree	Trend in urbanization
PIIGS		medium	stable
Greece	48.00%	medium	stable
Italy	36.80%	low	stable
Portugal	49.30%	medium	stable
Spain	59.50%	medium	stable
Western Peak		high	increasing
Netherlands	72.90%	high	stable
Sweden	23.10%	low	increasing
United Kingdom	75.80%	high	increasing
Western Stable		low	stable
Austria	35.20%	low	stable
Belgium	68.30%	high	decreasing
Denmark	23.20%	low	stable
Finland	30.40%	low	stable
France	36.00%	low	stable
Germany	43.10%	medium	stable
East Growth		low	mostly increasing
Bulgaria	18.90%	low	increasing
Czech Republic	24.20%	low	stable
Estonia	44.10%	medium	stable
Hungary	17.50%	low	stable
Latvia	50.00%	medium	increasing
Lithuania	27.90%	low	increasing
Poland	29.10%	low	increasing
Romania	10.90%	low	increasing
Slovakia	11.30%	low	stable

Source: Eurostat

The trends in employment may lead to two types of impacts. In quantitative terms, a recovery from the economic crisis should help achieve higher levels of employment in most EU Member States and, in turn, higher levels of car travel demand. The employed tend to use the car more often and for longer distances than the unemployed, so an increase in the number of employed persons would in principle lead to a proportional increase in car use. The qualitative changes of employment, however, i.e. the increasing share of part-time, remote or teleworking may lead to new patterns of transport demand. On one hand, new forms of work decrease the number of weekly trips to work but- on the other- trips become longer (since teleworkers tend to live farther away from their job) and use the car at higher frequency. Demographic trends would probably limit the increase in demand. The car use intensity of the generations entering retirement age in the next 10-15 years is probably the highest of all preceding and subsequent generations.

4 Conclusions

The results of the analysis presented here suggest that it is probably too early to assume that car travel demand is close to a peak throughout Europe. It would be more accurate to claim that a plateau has been reached in a few EU Member States with a developed economy, high car ownership rates and slowly changing demographic profiles. Evidence shows that in some of these countries car use has peaked. However, significant growth in car use should be expected in Eastern Europe. The trends concerning the use of passenger cars are certainly not uniform across the EU since each Member State has its own socio-economic conditions and follows a different path as regards car dependency.

In addition, some of the indications of changes in trends can be circumstantial or temporary, as for example the impacts that the economic crisis may have on car ownership and use. Others are long term and perhaps not clearly visible yet. The changing structure of the economy, the longer periods of education for the young, the more fragmented and deregulated labour market and the changing cultural values (i.e. the high value of digital connectivity) may be gradually changing the role of the car in the society in the long term, but there is still not sufficient evidence to suggest that they already are having an impact throughout Europe.

Part of the impact of the factors analysed here may simply be the result of postponing decisions related to car use. However, even postponement alters the total level of demand, for if one age group now makes fewer trips than it did before, it lowers the overall level of demand. Evidence also shows that the young groups who are now postponing driving a car do not reach the levels of car use in their 30s and 40s that the generation before had. Some who postpone using the car will forever abandon car driving.

The approach presented here sheds some light into the interaction of the variables that affect user choices as regards car use. It is clear that many of the factors are interdependent, as for example the level of urbanisation and the availability of public transport. The analysis of the importance of the factors allows the policy maker to identify better where policy measures can influence user choices. Targeted policies that address specific demographic groups or land use types in each individual country would be more successful than *one size fits all* approaches.

In conclusion, it is premature to talk about a paradigm shift in car use. The fluctuations in car activity and – in some countries- the apparent saturation of car ownership are to a large extent the results of a combination of economic and demographic trends that resulted in younger generations being –at least for the moment- less dependent on cars.

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